Homework #7: Fluid Boundary Layer Velocity Profiles

Due: Tuesday, May 6th by 4:00 PM (hard-copy & drop-box formats)

A fluid flowing over a motionless solid surface develops a *boundary layer* through which the fluid velocity *v* changes from zero at the surface *(y = 0)* to the freestream value *U* at the "edge" of the boundary layer. For a laminar flow, the velocity profile *v(y)* is given by the parabolic relationship:

$$v/U = 2(y/\delta) - (y/\delta)^2$$

Where δ is the boundary layer thickness which roughly defines the edge of the layer. For a turbulent flow, the velocity profile follows a power-law relationship:

$$v/U = (y/\delta)^{1/n}$$

For the experimental data given below of measured velocity vs. position, determine which profile laminar or turbulent best represents the flow using both the *Excel* 'solver' utility and the *Matlab* 'cftool'. **Plot the best-fit comparisons (as lines w/o points) superimposed on the experimental data observations (as points w/o lines)**; by convention set velocity as the abscissa and position as the ordinate as shown in the figures below. **Include a table of the 'optimal' values of δ, *U*, and *n (as appropriate)* that best fit the given data for each equation model & method employed**.

v (m/sec)	*y (μm)*	*v (m/sec)*	*y (μm)*
7.37	*50*	*41.78*	*550*
11.63	*100*	*44.53*	*600*
16.72	*150*	*48.48*	*650*
21.60	*200*	*46.95*	*700*
26.43	*250*	*49.16*	*750*
30.16	*300*	*50.29*	*800*
32.40	*350*	*49.72*	*850*
33.29	*400*	*50.69*	*900*
39.89	*450*	*52.05*	*950*
41.74	*500*	*51.80*	*1000*